STABILIZED PARALLEL FINITE ELEMENT METHOD FOR OROGRAPHIC WIND FLOW AND RAINFALL USING GIS

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A number of flood disasters due to rainfall occur annually in various parts of the world. In order to estimate the extent of a flood disaster quantitatively, it is necessary to estimate the rainfall accurately. Rainfall can be classified into two types, i.e., orographic rainfall and convective rainfall. Orographic rainfall is caused by the clouds produced by ascending wind flow due to the ups and downs of geological features. On the other hand, convective rainfall is caused by the clouds produced by the ascending wind flow due to the instability of the air layers. Some physical models for these types of rainfall have been presented in the past.

This paper presents a parallel finite element method for the analysis of orographic wind flow and rainfall. The Kessler model[1], which is the model for warm rain, is used in this paper. This model can be expressed by the conservation equations of cloud water and rainwater. The unsteady Navier-Stokes equation considering the change of air density is used for the governing equation, and the stabilized finite element method based on SUPG/PSPG[2] is employed for the spatial discretization. Parallel finite element scheme based on domain decomposition method and MPI is implemented on PC clusters. The P1/P1 element is employed for the discretization in space. The non-linear simultaneous finite element equation system is linearlized by the Newton-Raphson method, and the resulting linear equation system is solved using the matrix free GMRES approach[3]. The mesh generation method using GIS is also presented in this paper. In order to show the validity of this method, it has been applied to several numerical computations.

References

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